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**Cahill et al.**

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[54] **POLYMERIC LINER PLY FOR TUBULAR CONTAINERS AND METHODS AND APPARATUS FOR MANUFACTURING SAME**

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[51] Int. Cl.<sup>6</sup> ..... **C09J 7/02**

[52] U.S. Cl. .... **428/34.2; 428/34.3; 428/349; 428/354; 428/355 EN; 428/355 AC**

[58] Field of Search ..... **428/34.2, 34.3, 428/349, 354, 355 EN, 355 AC**

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Attorney, Agent, or Firm—Bell Seltzer Intellectual Property Law Group of Alston & Bird, LLP

### [57] ABSTRACT

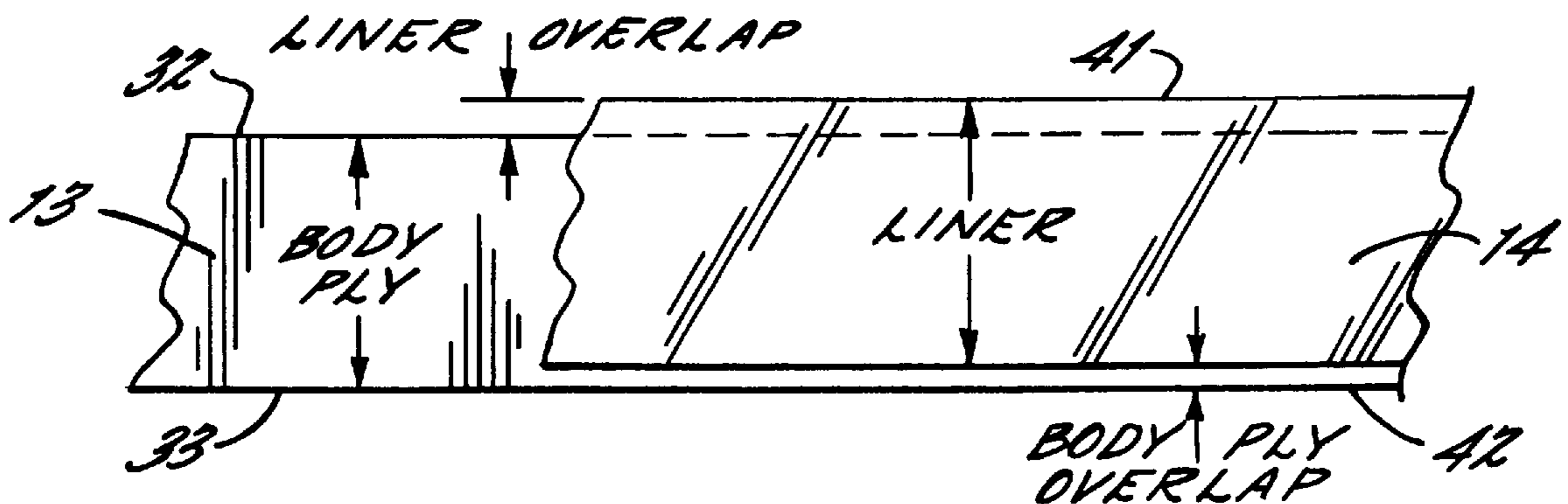
A method of manufacturing multi-ply tubular containers for food products is provided including the steps of advancing a continuous body ply formed of paperboard towards a shaping mandrel and advancing a continuous polymeric liner ply adjacent to one surface of the paperboard body ply. The polymeric liner ply includes a moisture barrier layer and an adhesive layer defining one surface of the liner ply, wherein the adhesive layer includes a polymeric adhesive which is activated at a predetermined activation temperature. The body ply is heated to a temperature above the activation temperature of the adhesive, and the body ply and the liner ply are then passed in face-to-face contact through a nip to adhere the liner ply to the body ply. The body ply and liner ply are then wrapped around a shaping mandrel to create the tubular container. Accordingly, an advantageous tubular container can be manufactured having an unsupported and polymeric liner ply which is adhered to a body ply without the application of any separate adhesives.

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15 Claims, 4 Drawing Sheets



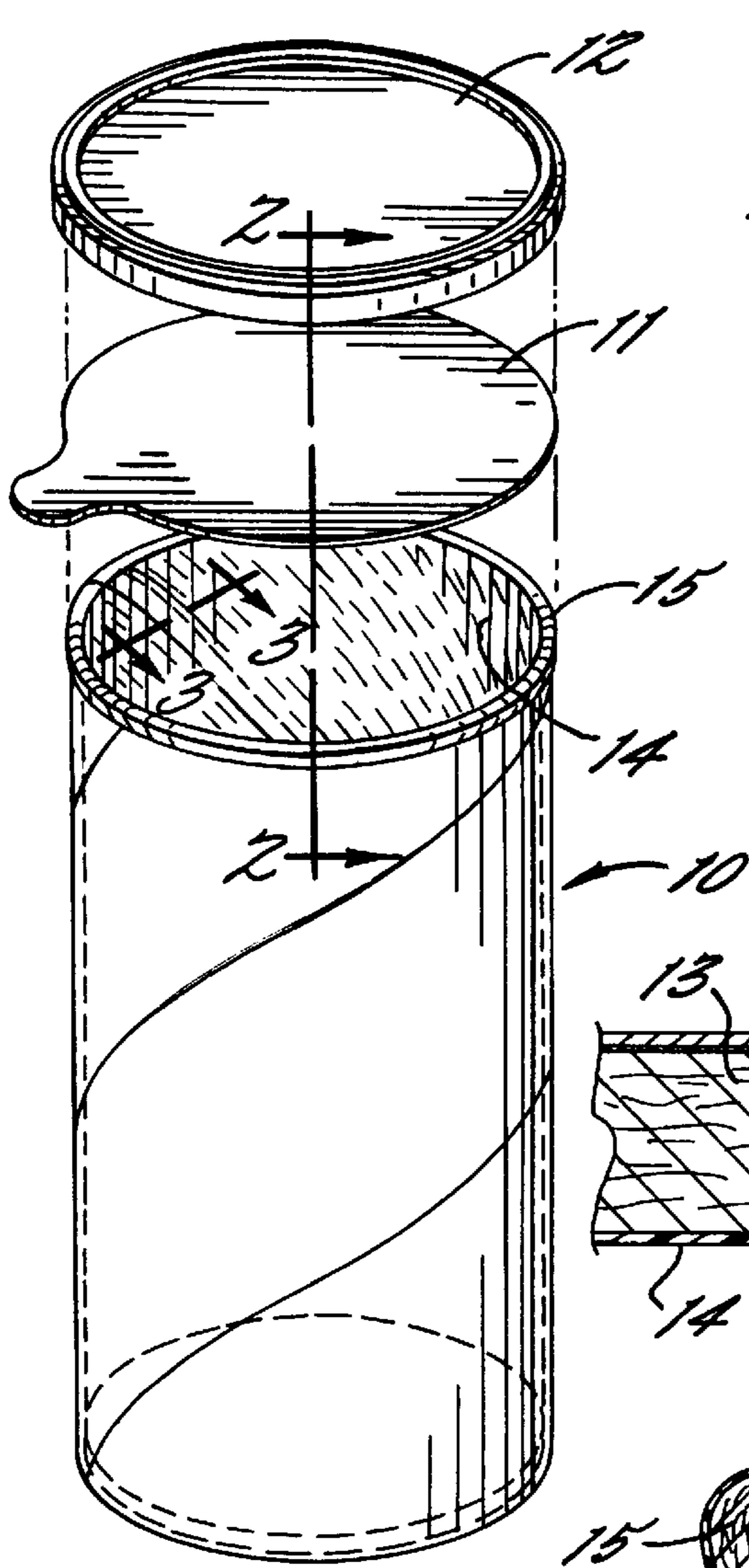


FIG. 1.

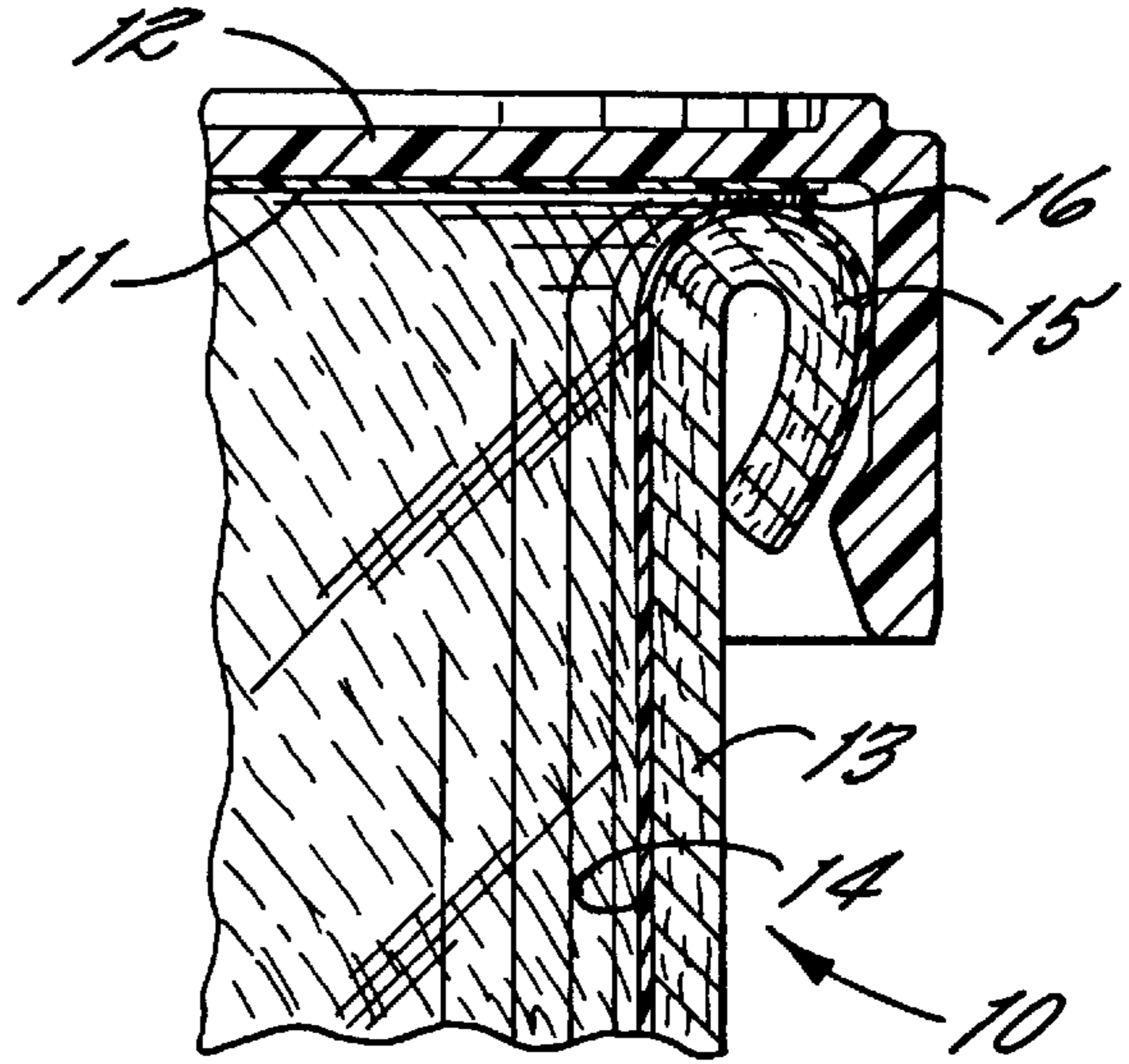


FIG. 2.

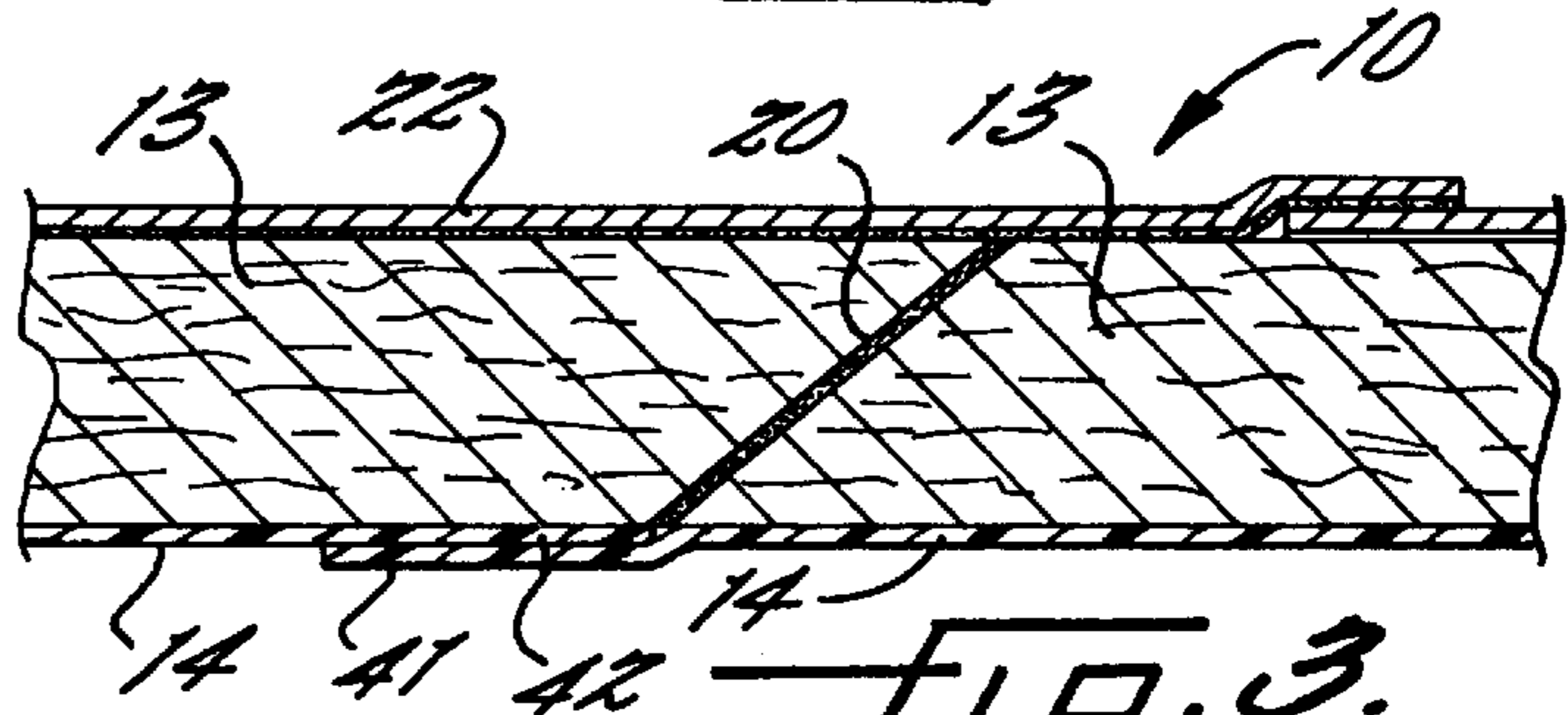


FIG. 3.

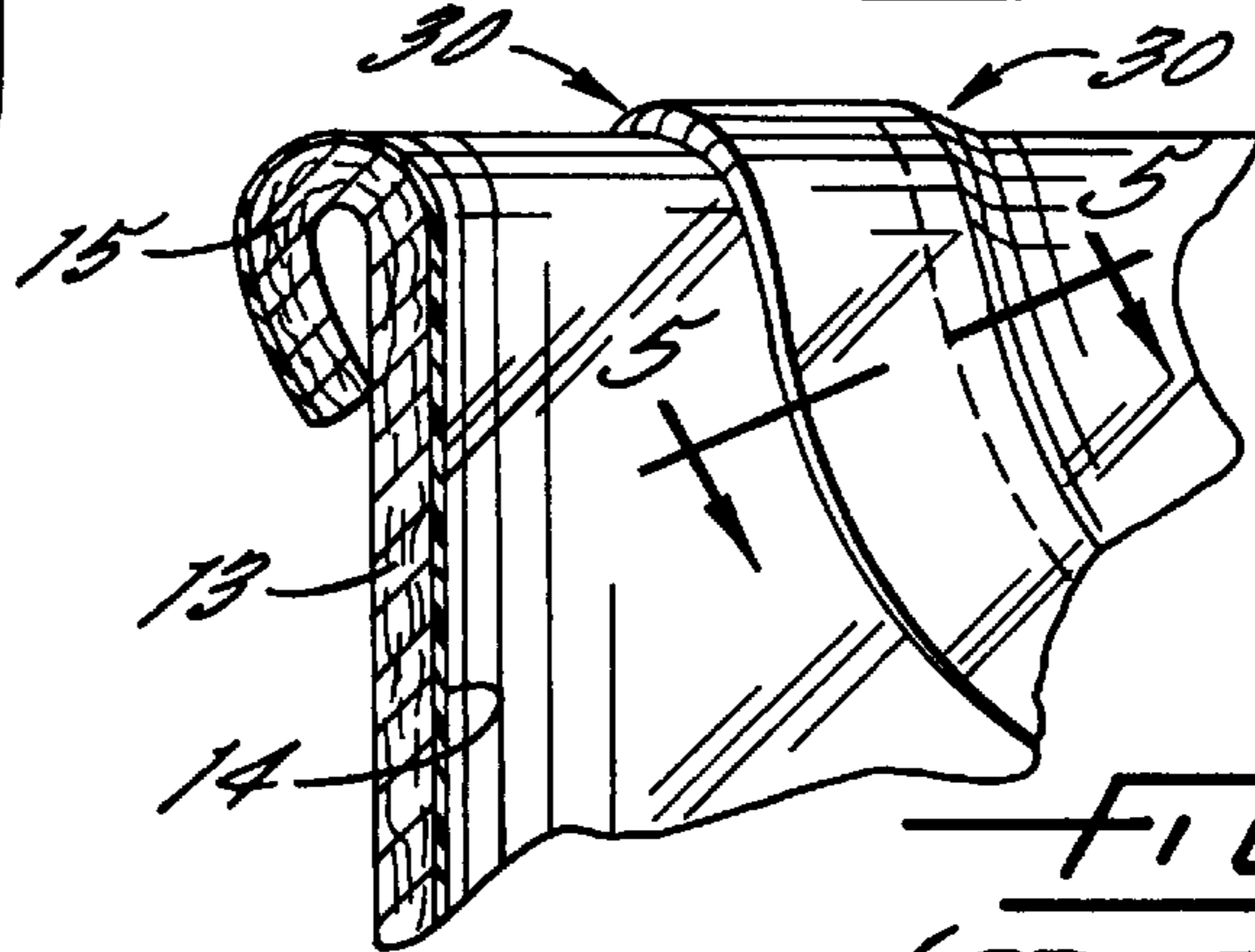


FIG. 4.  
(PRIOR ART)

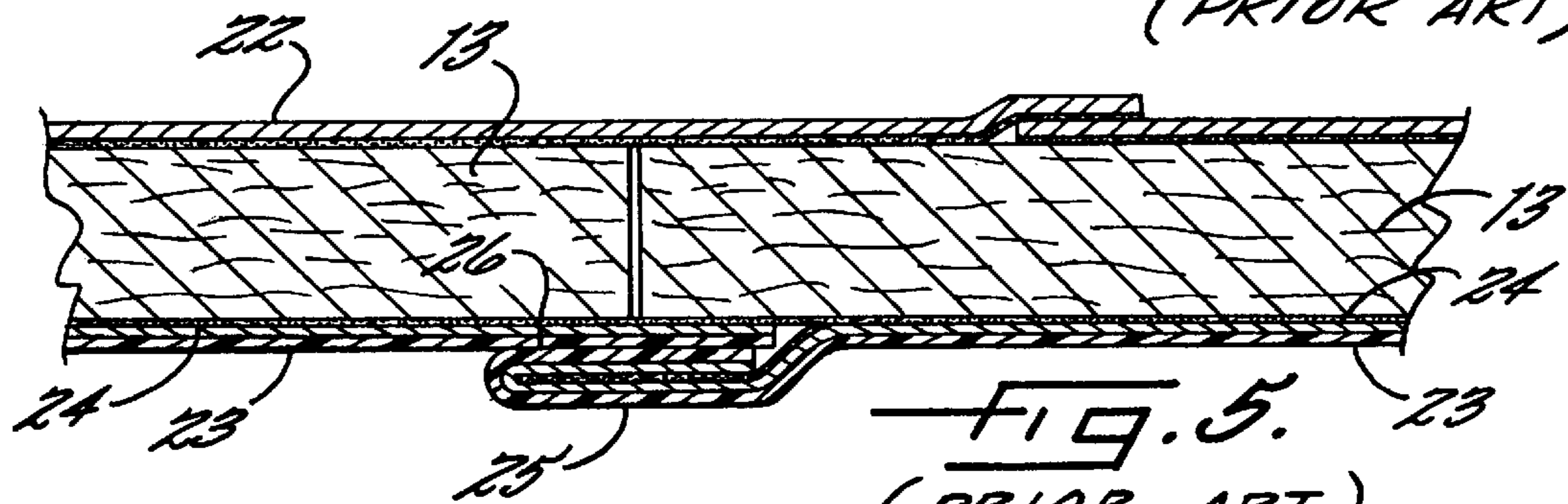
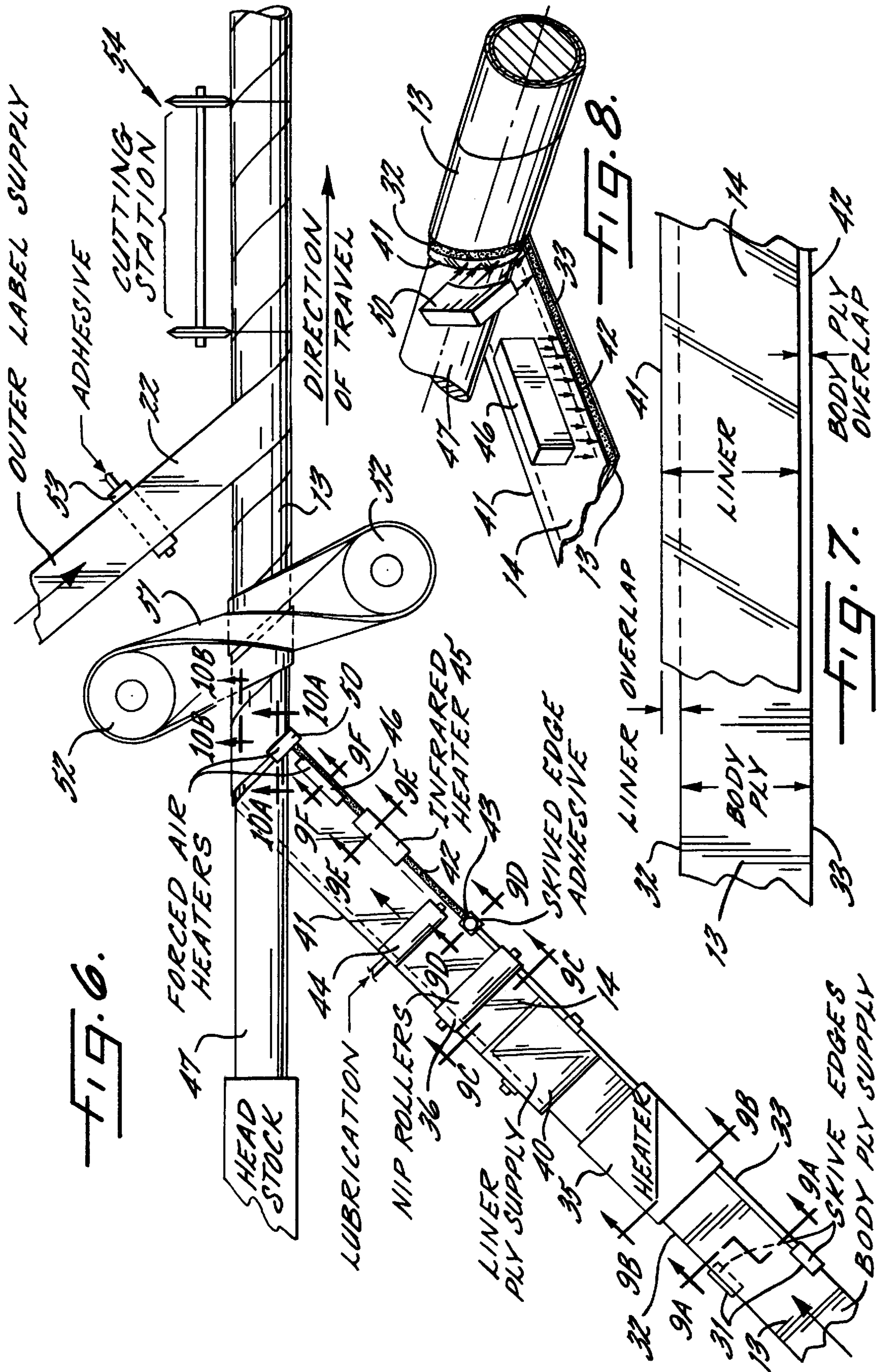
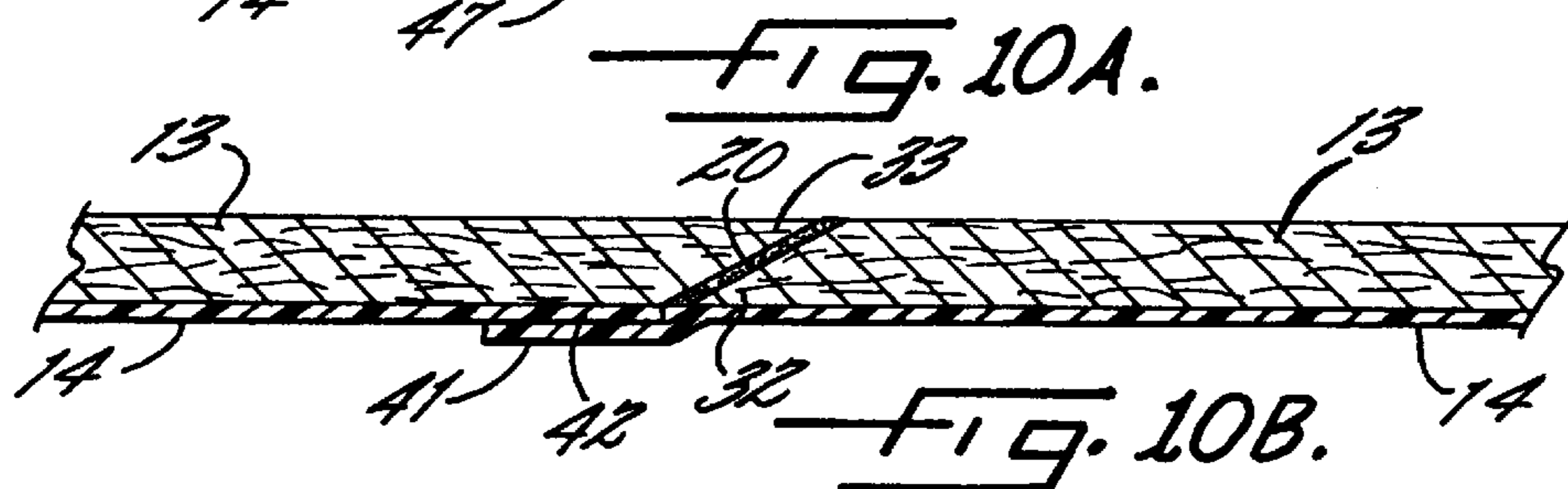
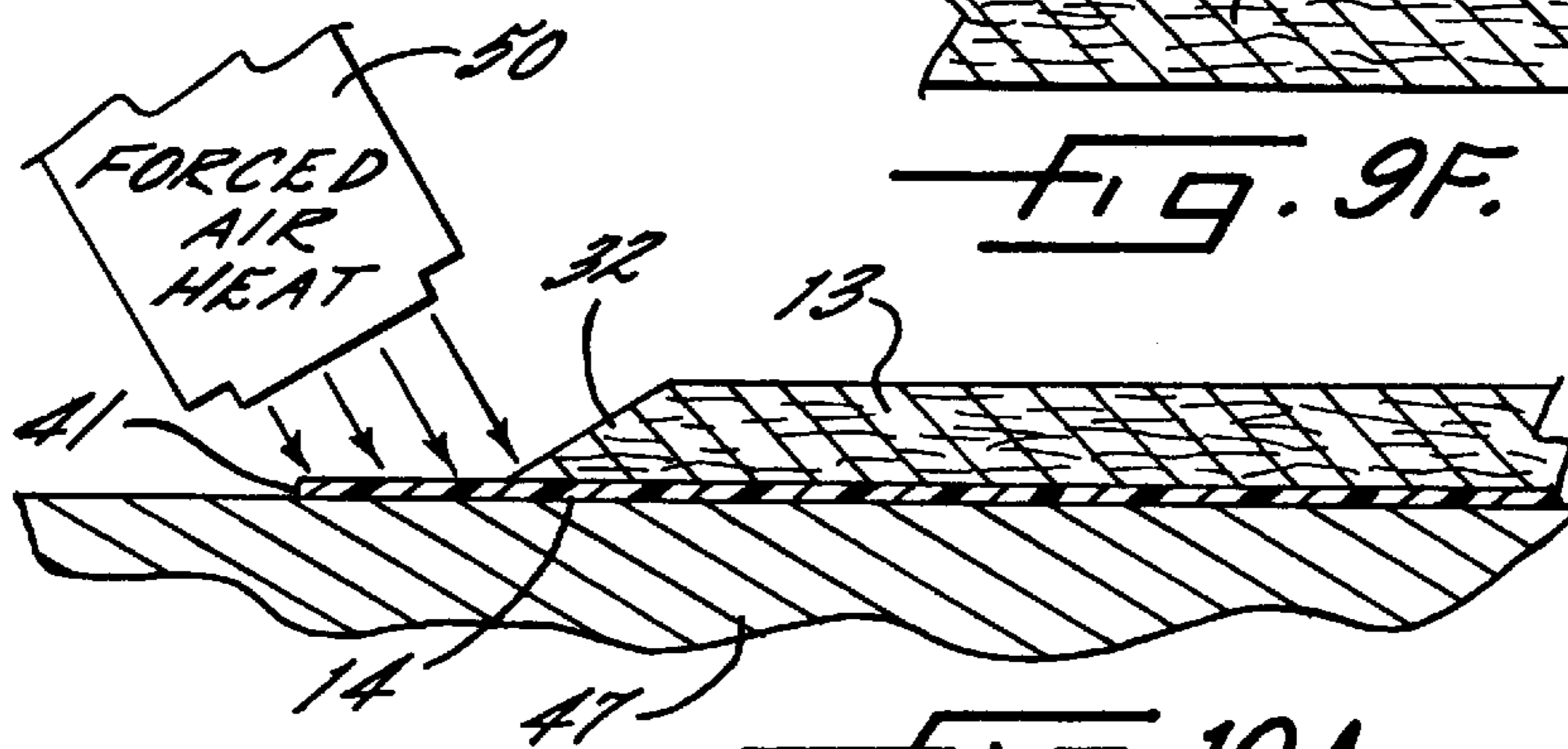
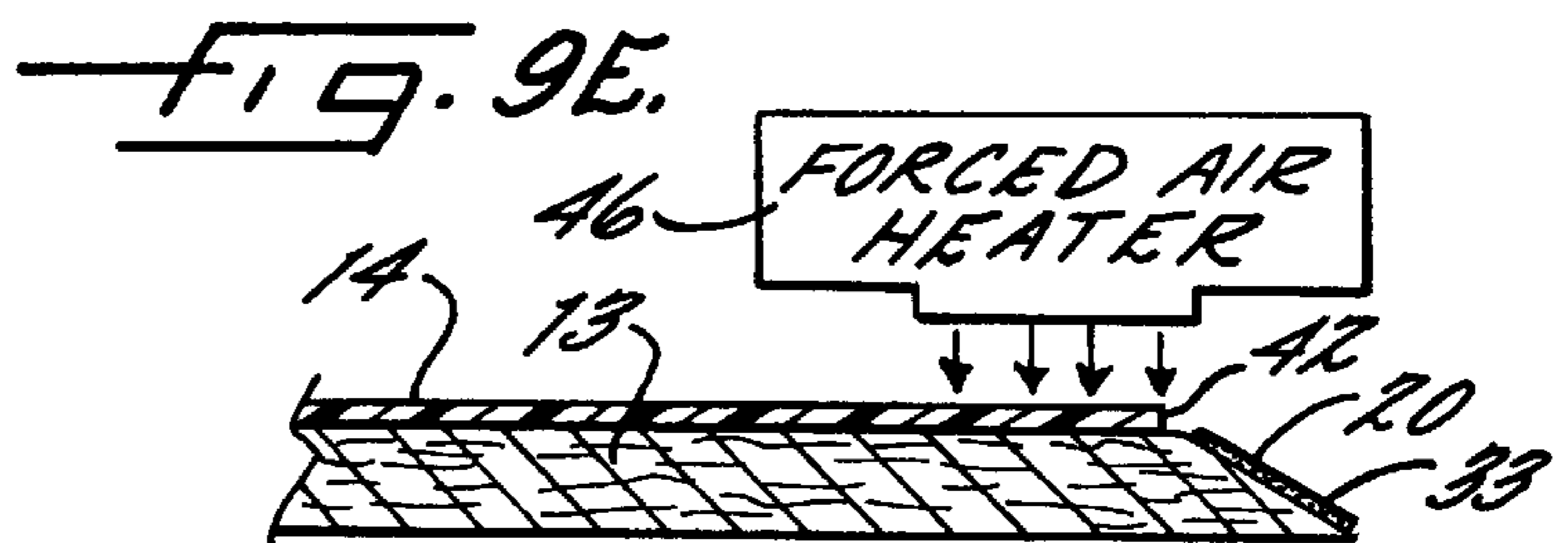
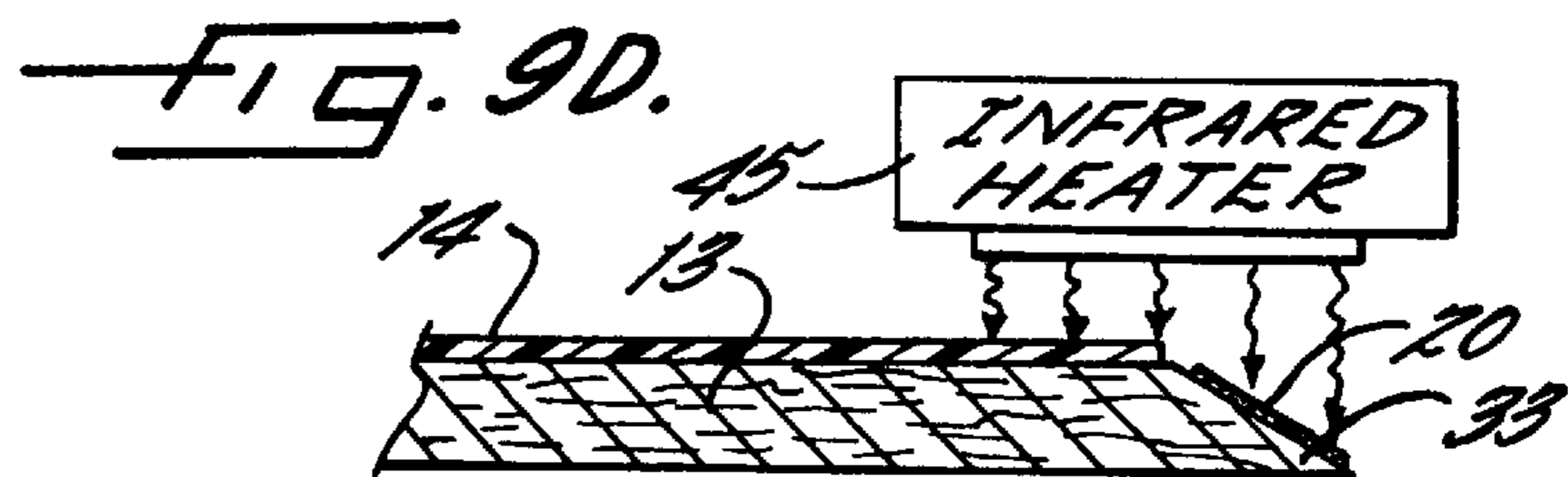
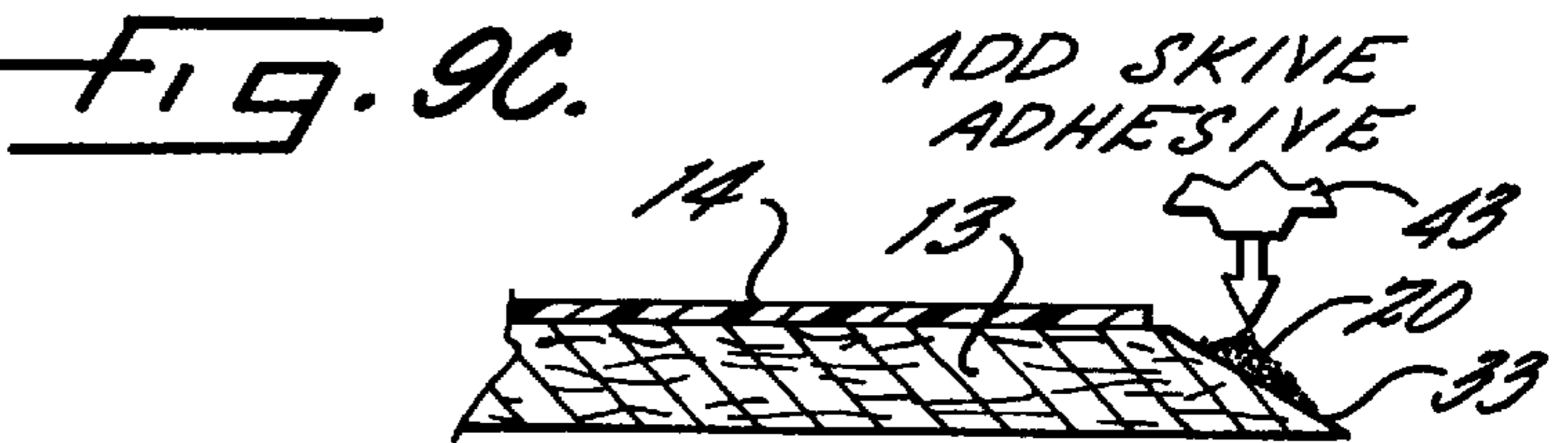
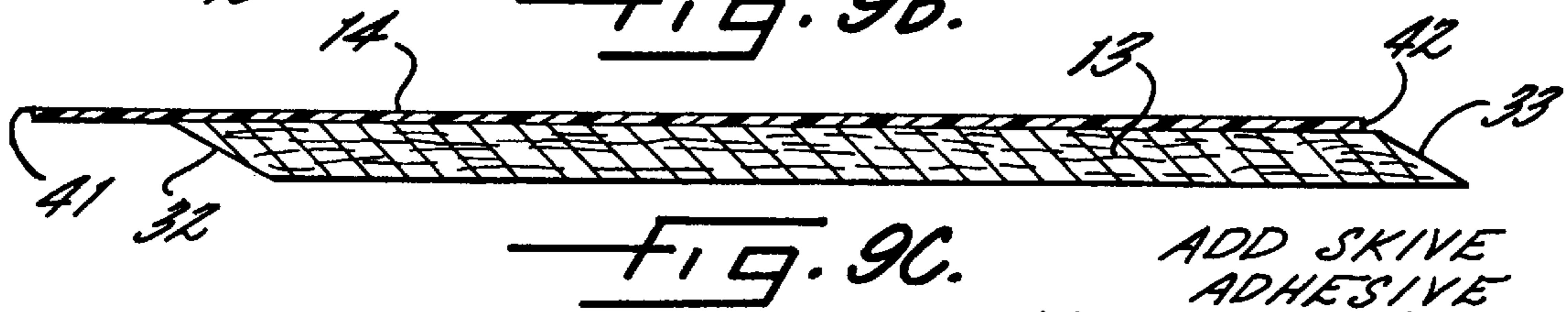
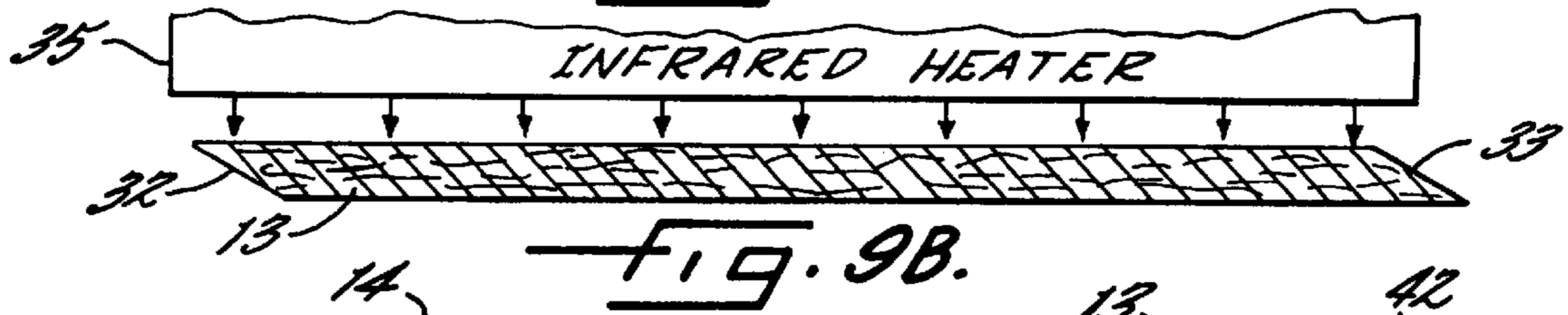
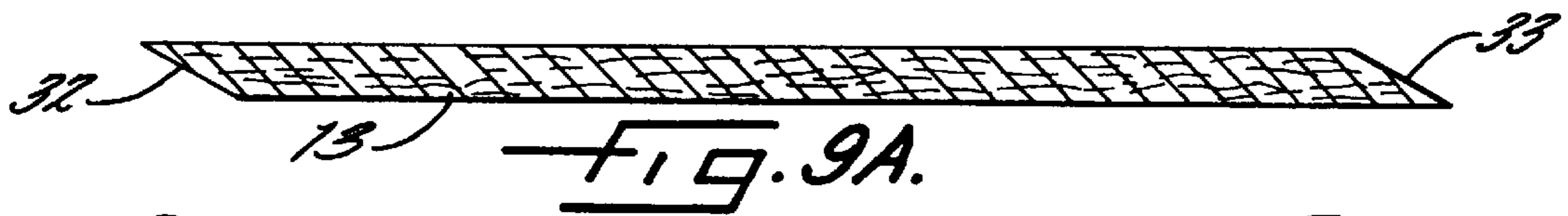
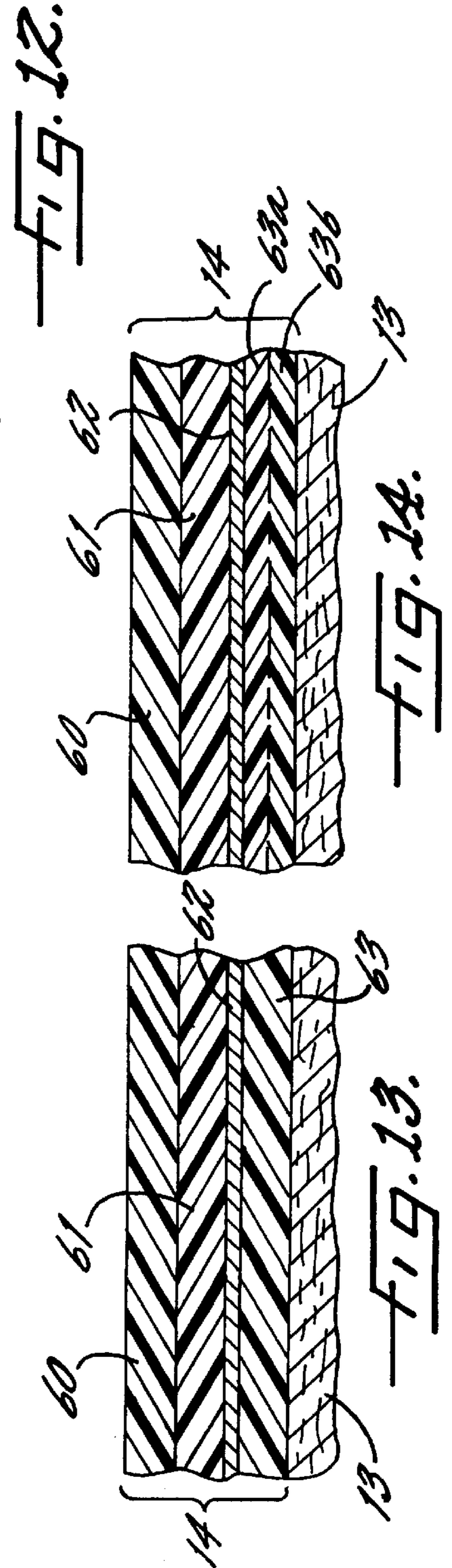
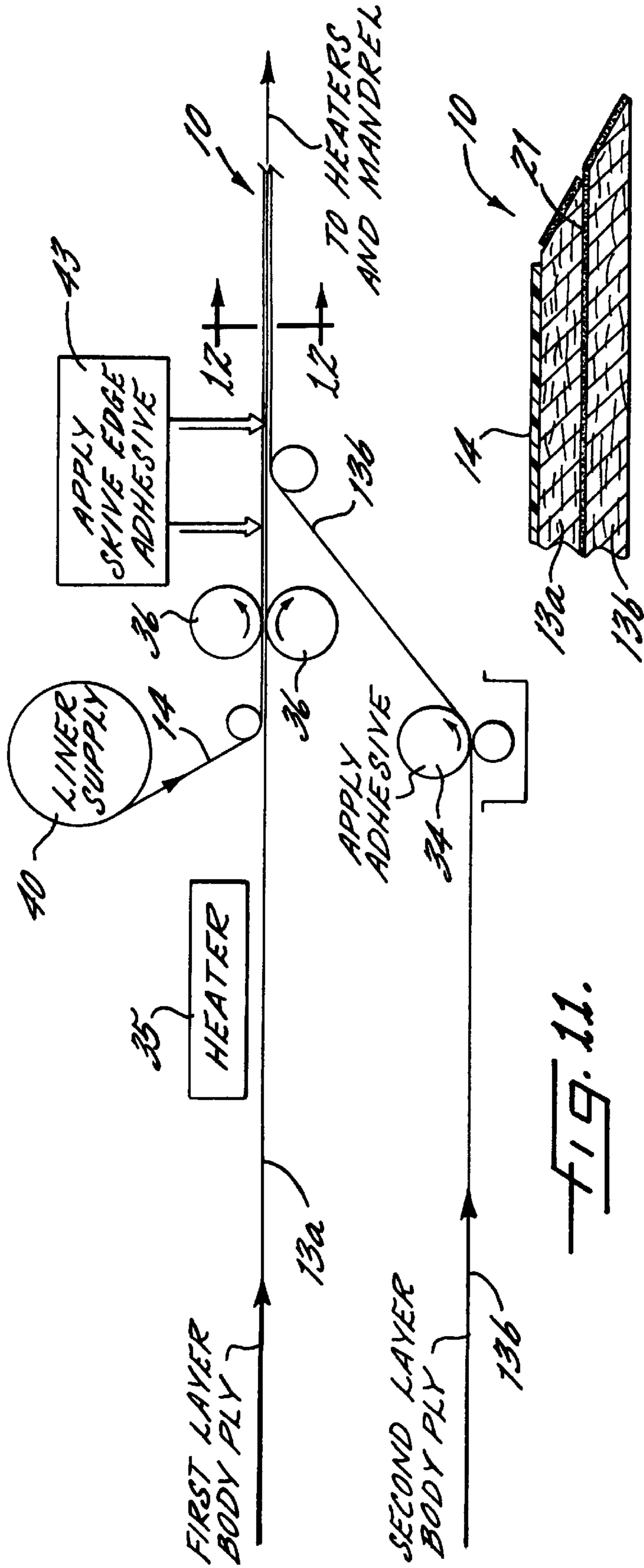


FIG. 5.  
(PRIOR ART)







**POLYMERIC LINER PLY FOR TUBULAR  
CONTAINERS AND METHODS AND  
APPARATUS FOR MANUFACTURING SAME**

The present invention relates to food containers and methods and apparatus for making food containers, and more particularly relates to tubular containers wound from at least one paperboard body ply and a liner ply.

**BACKGROUND OF THE INVENTION**

Food and drink products and other perishable items are often packaged in tubular containers which are sealed at both ends. These tubular containers typically include at least one structural body ply and are formed by wrapping a continuous strip of body ply material around a mandrel of a desired shape to create a tubular structure. The body ply strip may be spirally wound around the mandrel or passed through a series of forming elements so as to be wrapped in a convolute shape around the mandrel. At the downstream end of the mandrel, the tube is cut into discrete lengths and is then fitted with end caps to form the container.

Tubular containers of this type typically include a liner ply on the inner surface of the paperboard body ply. The liner ply prevents liquids such as juice from leaking out of the container and also prevents liquids from entering the container and possibly contaminating the food product contained therein. Preferably, the liner ply is also resistant to the passage of gasses, so as to prevent odors of the food product in the container from escaping and to prevent atmospheric air from entering the container and spoiling the food product. Thus, the liner ply provides barrier properties and the body ply provides structural properties.

Conventional liner plies are most often made of aluminum foil which has good barrier properties and also has advantageous strength properties. In particular, the liner is wound onto the mandrel prior to the winding of the body ply and must be sufficiently strong and stiff to be independently wound on the mandrel without stretching or wrinkling. Because of the support provided by the foil layer of the liner, such liners are known as "supported" liners.

One or more polymeric layers are normally adhered to the foil to further improve the barrier properties of the liner and it is sometimes the case that the foil layer is not necessary for barrier properties but is included in the liner only to provide support. Such foils are expensive and thus it is desired to provide an "unsupported" liner having the requisite barrier properties without the aluminum foil layer. However, because of the problems associated with winding an unsupported liner on the mandrel, such as stretching, creasing or other misshaping of the liner, it has not been commercially feasible with conventional winding apparatus and methods to manufacture a container having an unsupported liner ply.

In addition, the aluminum foil layer typically includes a kraft paper backing for allowing the foil layer to be adhered to the paperboard body ply. Aqueous based adhesives (or "wet adhesives") are preferably used to adhere the liner ply to the body ply because solvent based adhesives have become disadvantageous in light of various environmental concerns. However, it has heretofore been difficult to get the aqueous adhesives to stick to the smooth and impervious surface of the aluminum foil layer. Accordingly, a kraft paper backing has been preadhered to the foil layer so that the liner can be adhered to the paperboard body ply with wet adhesives. However, the kraft paper adds further cost and thickness to the liner.

The liner ply is also sealed to itself along a helical seam which is typically slightly offset from the helical seam of the body ply. Wet adhesives have typically not been able to adhere directly to the foil layer as discussed above, and thus the liner ply seam is formed with an "anaconda" fold, wherein the overlying edge of the liner ply is folded back on itself and adhered to the underlying edge. The anaconda fold allows the polymeric layers on the surface of the foil layer to be heat sealed together. Alternatively, a hot melt adhesive can be used to seal the anaconda fold of the overlying edge of the liner ply to the underlying edge. An additional advantage of the anaconda fold is that the edge of the kraft paper is not exposed to the interior of the container and thus liquids in the container will not be absorbed by the kraft paper. An example of such a fold is illustrated in U.S. Pat. No. 5,084,284 to McDilda, et al.

Anaconda folds are undesirable, however, because of their increased thickness. The thickness of an anaconda fold seam is equal to three thicknesses of the liner ply and poses difficulties when attempting to hermetically seal the ends of the tubular container. Specifically, the ends of the tube are often rolled outwardly after being cut so as to form a rolled circular bead or flange on one or both ends of the tube and then end caps or covers are sealed to the bead with an adhesive sealant or compound. However, in the area where the thick anaconda fold seam forms a portion of the edge surface, the end surface of the bead or flange can be substantially non-planar thus forming hill-like and/or valley-like irregularities. Accordingly, an extra amount of adhesive sealant must be applied to the edge surface at least in the area of the anaconda fold seam to fill the discontinuities and hermetically seal the tubular container. The additional application of adhesive sealant is disadvantageous because of the extra sealant which must be used and the increased difficulty in removing the seal by the consumer due to the additional adhesive sealant.

Prior tubular containers having a liner without an anaconda fold seam include the container disclosed in U.S. Pat. No. 3,520,463 to Ahlemeyer. The container disclosed therein includes a liner ply of aluminum foil which is coated on one surface to inhibit chemical attack. The liner ply web is fed to a pair of combining rolls where its uncoated surface is forced into contact with an adhesively coated surface of a body ply web. Solvent based adhesives are disclosed and include animal glue, casein-latex emulsion, vinyl-copolymer emulsion, and sodium silicate. The composite web is then spirally wound into tubular form about a mandrel to create a continuous tube. The overlapping edges of the liner ply are secured together with a hot melt adhesive.

A method of making wound tubular products without a water based adhesive is disclosed in U.S. Pat. No. 3,524,779 to Masters, et al. The method includes winding an inner ply made of a metal foil onto a shaping mandrel. An outer ply is then wound onto the mandrel from the opposite direction. A thermoplastic resin adhesive is precoated on the outer ply and optionally on the inner ply, and the outer ply is heated as it approaches the mandrel to activate the adhesive. A winding belt then firmly presses the plies together to obtain a solid container wall. As noted above, the metal foil provides a relatively stiff inner ply which allows the liner to be wound independently on the mandrel but which adds extra expense and thickness to the container construction.

U.S. Pat. No. 4,717,374 to Elias and assigned to the assignee of the present invention discloses a method for forming a composite container with a high barrier liner layer. The liner layer includes a metal layer of aluminum which is vacuum deposited on a resinous base film made of oriented

polyethylene terephthalate. The liner also includes a second resinous layer opposite the first so as to form a sandwich around the metallized layer. On the exposed surfaces of the first and second resinous films are surface layers of copolyester which are heat seal compatible with each other so that the liner can be sealed to itself along the seam.

The Elias patent notes that the surface layer adjacent to the product must have sufficient mobility over a winding mandrel to allow the tubes to be wound and that the opposite surface is adhered to the inner ply of the paperboard layer by any of the then known techniques. The liner is heated only along an edge thereof as the liner is wound onto the mandrel so that the heated edge is heat sealed to the opposite edge of the preceding convolution. Heating more than the edge would cause the liner to adhere to the mandrel. The paperboard layer and label layer are then wound over the edge-sealed liner layer. Although the Elias patent discloses an exemplary liner, conventional techniques are disclosed for adhering the liner to the paperboard ply and as such include the added steps of separately applying an adhesive and/or precoating the paperboard with some type of adhesive or adherable surface to allow the liner ply to the adhered thereto.

Accordingly, it would be desirable to provide methods and apparatus for manufacturing a tubular container having an unsupported liner ply which does not include a foil layer and which could be sealed without using an anaconda fold seam. In addition, it would be highly desirable to provide such a container wherein the liner ply is securely adhered to the body ply without the separate application of a solvent based or water based adhesive and without precoating the inner surface of the body ply. It would be especially desirable if these objects and advantages could be combined in the same container.

#### SUMMARY OF THE INVENTION

These and other objects and advantages are met by the present invention which include methods and apparatus for manufacturing a tubular container having a paperboard body ply and a polymeric liner ply adhered thereto, wherein the liner ply includes a barrier layer and an adhesive layer that defines one surface of the liner ply. In particular, the adhesive layer includes a polymeric adhesive capable of bonding to the paperboard. The liner ply is bonded to the paperboard before being wound on the mandrel and does not suffer from the wrinkling problems associated with the prior art.

A method according to the present invention of manufacturing multi-ply tubular containers for food products includes the steps of advancing a continuous body ply formed of paperboard having first and second side edges towards a shaping mandrel, and advancing a continuous polymeric liner ply having first and second marginal edge portions adjacent the edges thereof toward the mandrel while positioning one exterior surface thereof adjacent to one face of the paperboard body ply. The liner ply preferably has a barrier layer resistant to the passage of liquids and gasses and an adhesive layer that defines one exterior surface of the liner ply. The adhesive layer includes a polymeric adhesive which is activated at a predetermined activation temperature and allows high speed commercial winding.

The liner ply and the body ply are then passed in face-to-face contact through a pair of nip rollers with the adhesive layer of the liner ply adjacent to the body ply. Preferably, the passing step includes aligning the liner ply and the body ply such that the first marginal edge portion of the liner ply

extends laterally beyond the first side edge of the body ply. The portion of the adhesive layer of the liner ply that contacts the body ply is heated to a temperature above the activation temperature of the adhesive so that the liner ply becomes adhered to the body ply. Preferably, the heating step includes heating the paperboard body ply with a heat source and then passing the liner ply and body ply in face-to-face contact through the nip rollers so that heat is transferred from the body ply to the liner ply upon contact to activate the adhesive.

The body ply and adhered liner ply are then wrapped around the shaping mandrel so that the second edge of the body ply engages the first edge of the body ply and so that the second marginal edge portion of the liner ply engages the first marginal edge portion of the liner ply in face-to-face contact. The body ply may be wrapped spirally or longitudinally around the mandrel to create spiral or convolute tubes. Preferably, the first marginal edge portion of the liner ply is also heated to a temperature above the activation temperature of the adhesive so that the first marginal edge portion of the liner ply becomes adhered to the second marginal edge portion. Heating the first marginal edge portion of the liner ply advantageously includes heating the first marginal edge portion while the liner ply is wrapped on the mandrel. In addition, the mandrel is also preferably heated.

Another aspect of the present invention is a multi-ply tubular container for food products which includes at least one body ply formed of an uncoated fibrous paperboard which is wrapped in a tubular shape. The container also includes a polymeric liner ply having a radially interior inner surface and an outer surface adhered to the radially interior inner surface of the body ply. The liner ply preferably has a thickness of less than about three mils and includes a polymeric moisture barrier layer that is more preferably also an oxygen barrier resistant to the passage of liquids and gasses. The barrier layer preferably includes at least one of the group of polyester, nylon, ethylene vinyl alcohol copolymer and blends thereof. In highly preferred embodiments the barrier layer has at least one metallized surface.

The adhesive layer preferably includes inner and outer sublayers each having a heat activatable polymeric adhesive including a polymer from the group consisting of ethylene vinyl acetate, ethylene acrylic acid, ethylene methacrylic acid, ethylene methyl acrylate and blends thereof. The inner sublayer advantageously has an adhesive which is adhered to the barrier layer and the outer sublayer has a different adhesive which is adhered directly to the fibers of the body ply prior to the body ply being wrapped. The outer and inner sublayers of the adhesive layer may be coextruded. The liner ply may also include a seal layer defining the inner surface of the liner ply and having a melting temperature higher than the temperature at which the adhesives of the adhesive layer become activated. The seal layer may include a polyolefin polymer such as high density polyethylene.

The present invention thus provides a polymeric liner that does not suffer from the problems associated with liners including a foil layer. The liner ply according to the invention is thinner and does not require an anaconda fold seam. In addition, the liner ply is adhered to the paperboard without a separate adhesive application step and without the need to precoat the paperboard for adhesion. The liner ply is prebonded to the paperboard and thus does not suffer from stretching or creasing when wound onto the mandrel.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Some of the objects and advantages of the present invention having been stated, others will appear as the description

proceeds when taken in conjunction with the accompanying drawings, which are not necessarily drawn to scale, wherein;

FIG. 1 is an exploded perspective view of a tubular container according to the present invention;

FIG. 2 is a fragmentary and enlarged sectional view of an end of the tubular container taken along lines 2—2 of FIG. 1;

FIG. 3 is an enlarged sectional view of a paperboard body ply and a polymeric liner ply taken along lines 3—3 of FIG. 1;

FIG. 4 is a fragmentary and enlarged sectional view of an anaconda fold seam according to the prior art;

FIG. 5 is an enlarged sectional view of the anaconda fold seam of the prior art taken along lines 5—5 of FIG. 4;

FIG. 6 is a plan view of an apparatus according to the present invention for making a tubular container;

FIG. 7 is an enlarged plan view of a section of the apparatus illustrating the alignment of the liner ply relative to the body ply;

FIG. 8 is a perspective view of a section of the apparatus illustrating the winding of the body and liner plies onto a mandrel;

FIG. 9A is an enlarged sectional view of the body ply taken along lines 9A—9A of FIG. 6;

FIG. 9B is an enlarged sectional view of the body ply illustrating the heating thereof taken along lines 9B—9B of FIG. 6;

FIG. 9C is an enlarged sectional view of the body ply and the polymeric liner ply adhered thereto and taken along lines 9C—9C of FIG. 6;

FIG. 9D is a fragmentary and enlarged sectional view of one edge of the body ply illustrating the application of a skived edge adhesive taken along lines 9D—9D of FIG. 6;

FIG. 9E is a fragmentary and enlarged sectional view illustrating the application of infrared heat to the edge of the body ply taken along lines 9E—9E of FIG. 6;

FIG. 9F is a fragmentary and enlarged sectional view of the body ply illustrating the application of forced air heat to the edge of the body ply taken along lines 9F—9F of FIG. 6;

FIG. 10A is a fragmentary and enlarged sectional view of the edge of the body ply opposite the edge illustrated in FIGS. 9A—9F illustrating the application of forced air heat and taken along lines 10A—10A of FIG. 6;

FIG. 10B is a fragmentary and enlarged sectional view of adjacent body and liner plies illustrating the seams between the plies;

FIG. 11 is a schematic elevational view of an apparatus for manufacturing a tubular container having two body plies according to another embodiment of the invention;

FIG. 12 is a fragmentary and enlarged sectional view of one edge of the body plies adhered together in the apparatus of FIG. 11;

FIG. 13 is a greatly enlarged sectional view of a liner ply according to the invention adhered to the body ply; and

FIG. 14 is a greatly enlarged sectional view of a liner ply of another embodiment of the invention.

#### DETAILED DESCRIPTION OF THE INVENTION

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown.

This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout.

A tubular container 10 according to the present invention is illustrated in FIG. 1. Although illustrated as having a circular cross section, the tube may have any cross sectional shape which can be formed by wrapping the tube around an appropriately shaped mandrel. One example is a generally rectangular shaped tube having rounded corners.

The embodiment illustrated in FIG. 1 is particularly advantageous for packaging potato crisps and includes a flexible foil seal 11 and a reusable plastic end cap 12 over the seal. Various other end closures may be used, however, depending upon the type of food product which is to be packaged such as, for example, dough.

As illustrated in more detail in FIG. 2, the tubular container 10 includes a wall having a body ply 13 which is preferably formed of paperboard and a liner ply 14 which is preferably formed of a polymeric material adhered to the inner surface of the body ply 13. The upper end of the tubular container 10 is rolled over so as to form a bead 15 or flange and the foil seal 11 is hermetically sealed to the top of the bead with an adhesive sealant 16. The end cap 12 is then snapped over the bead 15 and may be reused after the foil seal 11 has been removed. A metal closure (not illustrated) can be secured to the opposite end of the container 10.

The seams where the various plies are joined together are illustrated in FIG. 3. The paperboard body ply 13 is made of a relatively thick and stiff paperboard. Accordingly, the edges are first skived and then joined together during the tube forming process with an adhesive 20 to create a strong seam. The liner ply 14 is adhered to the inner surface of the body ply 13 and the overlapping edges of the liner ply are adhered together to ensure that the container 10 is completely sealed. A label ply 22 is preferably adhered to the outer surface of the body ply 13 having various indicia printed thereon regarding the product within the container.

FIGS. 4 and 5 illustrate conventional tubular containers which include a liner having an aluminum foil layer 23 for providing strength and barrier properties to the liner. As discussed above, because conventional wet adhesives have been unable to adhere to aluminum foil, a kraft paper layer 24 is preadhered to the aluminum foil layer 23.

The kraft paper layer 24 cannot be exposed to the interior of the container because liquids and gasses could pass through the porous and absorbent kraft paper layer. For example, if a straight lap seam, such as that shown in FIG. 3, were employed at the edges of the liner 14, one edge of the kraft paper layer 24 would be exposed and would cause liquids in the container to wick through the kraft paper layer and leak from the container. Accordingly, an anaconda fold must be used at the seam wherein an overlying edge portion 25 of the liner is folded back on itself and then sealed to an underlying edge portion 26 of the liner as illustrated in FIG. 5. The overlying liner edge portion 25 may be adhered to the underlying liner edge portion 26 by way of a hot melt adhesive (not shown). Alternatively, the aluminum foil layer 23 most often includes a thin polymeric layer (not shown) on the surface thereof facing the interior of the container which can be heat sealed to itself at the point where the overlying liner edge portion 25 contacts the underlying liner edge portion 26.



One disadvantage of such a liner arises at the point where the anaconda fold seam extends over the bead **15** as illustrated in FIG. 4. Specifically, the thick anaconda fold seam creates a pair of step discontinuities **30** along the periphery of the bead **15**. This presents difficulties when sealing the foil seal **11** to the bead **15** and is typically overcome by applying extra adhesive sealant **16** to the foil seal or the bead to fill the discontinuities **30**. The use of this added adhesive sealant **16** is disadvantageous because of the expense of the extra material used and the complexity of applying added sealant to those areas.

An apparatus for making tubular containers which overcomes the disadvantages of conventional tubular containers is illustrated in FIG. 6. A continuous strip of paperboard body ply material **13** is supplied to the apparatus and is first passed through a pair of opposed edge skivers **31**. As illustrated in FIG. 9A, the edge skivers remove part of the square edge of the body ply **13** to create first **32** and second **33** edges having a beveled configuration.

If desired, the body ply **13** may then be advanced through an adhesive applicator (not shown) which applies an aqueous adhesive to the upper surface of the body ply **13**. An advantageous tubular container incorporating an aqueous adhesive and methods and apparatus for manufacturing the same, are disclosed in copending U.S. patent application Ser. No. 08/796,793 filed concurrently herewith, which is assigned to the assignee of the present invention and is incorporated herein by reference. In the present invention, however, the separate application of a liquid adhesive is obviated.

The body ply **13** is then passed underneath a heater **35**. The heater **35** is preferably an infrared heater which supplies a sufficient amount of heat to the body ply **13** to activate an adhesive layer **63** in the liner ply **14** when the plies are nipped together, as discussed below. An infrared heater capable of generating a heat flux of at least about 200,000 W/m<sup>2</sup> has been determined to be sufficient at line speeds of about 50 ft./min. although line speeds up to 400 ft./min. are contemplated. It will be understood by one of ordinary skill in the art, however, that the various other heat sources, e.g., forced air heating or the like can be used and that the appropriate amount of heat can vary depending on various factors including the efficiency of the heat source, the speed of the body ply and the type of adhesive used.

After the heater **35**, the body ply **13** is then advanced into a pair of opposed nip rollers **36**. A continuous strip of liner ply material **14** is fed from a reel **40** and is also advanced into the nip adjacent to the body ply **13**. Heat is transferred from the heated body ply **13** to the liner ply **14** and the adhesive layer **63** is activated so that the liner ply **14** becomes adhered to the body ply **13**.

A preferred liner construction is illustrated in FIGS. 13 and 14 and includes a seal layer **60**, a moisture barrier layer **61** and the adhesive layer **63**. The moisture barrier layer **61** is resistant to the passage of liquids and preferably also gasses such as oxygen. If a barrier is required for both liquids and gasses, a preferred barrier material is polyester. Some food products, however, do not require a gas barrier, such as various juices, and other barrier materials may be used (although the barrier may also be generally resistant to the passage of gasses). It will be understood that various barrier materials or properties could be employed depending upon the item being packaged.

Alternative barrier materials include nylon, EVOH (ethylene vinyl alcohol polymer and copolymer), polyvinylidene chloride, polyethylene and polypropylene and the

like as will be apparent to the skilled artisan. One surface of the barrier layer **61** may include a thin metallized coating **62** to provide a metallic appearance and also to enhance the barrier properties. The metallized coating **62**, which may be formed of aluminum, is significantly thinner than a foil layer, however, and is not necessary for strength or barrier properties in certain applications. Thus, a thick and expensive foil sheet layer is advantageously eliminated. The liner ply **14** preferably has a total thickness less than about 3 mils and is more preferably closer to 1 mil in thickness.

The liner ply **14** is aligned through the nip with the body ply **13** such that a first marginal edge portion **41** of the liner ply extends beyond the first edge **32** of the body ply. The liner ply **14** may have the same width as the body ply **13** and thus the opposite second marginal edge portion **42** of the liner ply does not extend all the way to the second edge **33** of the body ply. Alternatively, the liner ply **14** may be wider or narrower than the body ply **13** depending on the amount of liner overlap which is desired. This configuration can be seen in the plan view of FIG. 7 and the sectional view of FIG. 9C.

After the nip rollers **36**, the body ply **13**/liner ply **14** laminate is passed under a skive adhesive applicator **43** which applies the skive adhesive **20** to the beveled surface of the skived second edge **33** of the body ply **13**. The skive adhesive **20** is preferably a hot melt adhesive of the type which is conventional in the art although could also be an other polymeric-type adhesive. The skive adhesive **20** helps provide a stronger body ply bond especially for single body ply containers.

The surface of the liner ply **14** may then be coated with lubricant from a roller **44** which allows the liner **14** to slide smoothly during the winding operation. If making the embodiment of the container discussed below, however, the lubricant can be advantageously eliminated or greatly reduced.

The laminate is then passed under an infrared heater **45** which heats the second marginal edge portion **42** of the liner ply **14** and also may heat the second edge **33** of the body ply **13**, as can be seen in FIG. 9E. An infrared heater capable of generating a heat flux of at least about 83,000 W/m<sup>2</sup> has been determined to be sufficient. After the infrared heater **45**, the second marginal edge portion **42** of the liner ply **14** is then passed under at least one forced air heater **46**.

The body ply **13**/liner ply **14** laminate is then wrapped around a shaping mandrel **47**. The laminate is first wrapped under the mandrel **47** and then back over the top in a helical fashion with the liner ply **14** wound against the surface of the mandrel. The first marginal edge portion **41** of the liner ply **14** is exposed on the mandrel **47** and is subjected to heat from a second forced air heater **50** as can be seen in FIGS. 8 and 10A. As the laminate is further wrapped and the first edge **32** of the body ply **13** advances back under the mandrel **47** after one complete revolution, it is brought into contact with the second edge **33** of the ensuing portion of the body ply **13** which is first coming into contact with the mandrel. The skived edges **32**, **33** become abutted together and the skive adhesive **20** adheres the edges together to form a spirally wound tube which advances along the mandrel **47**. With regard to the liner ply **14**, the first marginal edge portion **41** is brought into an overlapping relationship with the second marginal edge portion **42** to create a sealed straight lap seam as illustrated in FIG. 10B. The present invention thus eliminates the disadvantages associated with anaconda fold seams and uses a straight overlapping seam instead.

An adhesive layer **63** is below the metallized coating **62** and defines the outer surface of the liner ply **14**. The adhesive layer **63** includes a non-aqueous polymeric adhesive which is activated at a predetermined activation temperature. Such adhesives, which are also known as “dry-bond” adhesives, can include one or more of the following polymers or modified copolymers thereof; ethylene vinyl acetate, ethylene acrylic acid, ethylene methacrylic acid, ethylene methyl acrylate and blends with each other or lower cost polyolefins. A preferred embodiment is illustrated in FIG. **14** and includes an adhesive layer having two sublayers **63a,b** which are coextruded together. The inner sublayer **63a** is preferably ethylene acrylic acid which adheres well to the polyester barrier layer **61** and the outer sublayer **63b** is preferably ethylene methyl acrylate which adheres well to the paperboard body ply **13**.

A seal layer **60** may also form a part of the liner ply **14** and defines the inner surface of the liner ply. The seal layer **60** provides a surface against which the adhesive layer **63** is adhered when the first marginal edge portion **41** of the liner ply **14** is brought into an overlapping relationship with the second marginal edge portion **42**. The seal layer **60** includes a polyolefin polymer which is preferably high density polyethylene.

One advantageous feature of the seal layer **60** is that it has a higher melting temperature than the adhesive layer **63**. As noted above, the first marginal portion **41** of the liner ply **14** is raised to a temperature (whether heated before reaching the mandrel **47** or while on the mandrel **47**) such that the adhesive layer **63** is activated. However, if the seal layer **60** was made of the same polymer as the adhesive layer **63** or had a melting temperature equal to or less than the melting temperature of the adhesive layer, the seal layer would be melted and inclined to stick to the mandrel **47**, which would greatly impede the winding process. This problem would be especially acute with the apparatus according to the present invention because the mandrel **47** is preferably heated to minimize heat loss from the liner ply **14** to the mandrel. The present invention does not suffer from this problem, however, because the seal layer **60** has a melting temperature higher than the activation temperature of the adhesive layer **63**.

The tube is then advanced down the mandrel **47** by a conventional winding belt **51** which extends around a pair of opposed pulleys **52**. The winding belt **51** not only rotates and advances the tube, but also applies pressure to the overlapping edges of the body ply **13** and liner ply **14** to ensure a secure bond between the respective ply edges.

An outer label ply **22** is then preferably passed over an adhesive applicator **53** and wrapped around the body ply **13**. The label ply **22** could be applied before the winding belt **51**. A conventional adhesive may be used as illustrated or, optionally, the label ply **22** could be formed having an adhesive layer and a seal layer and be applied to the outer surface of the body ply **13** without a separate liquid adhesive in accordance with the method discussed herein used to apply the liner ply. At a cutting station **54**, the continuous tube is cut into discrete lengths and removed from the mandrel **47**.

The ends of the containers **10** are then rolled outwardly to form the bead **15** or a flange. Another advantageous feature of the polymeric liner ply according to the present invention is that the elasticity of the polymer causes the bead **15** to be locked in place once rolled. Conventional inelastic foil liners may have a tendency to unroll the bead **15** or crack which can present a problem when sealing the ends.

After being filled with the food product, a foil seal **11** preferably is sealed on one or both ends of the container **10**. The unsupported liner ply **14** according to the present invention is significantly thinner than conventional foil liners and a straight lap seam can be used instead of an anaconda fold seam. Accordingly, much smaller discontinuities are presented at the point where the seam crosses the bead, and the foil seal **11** can be cheaply and easily sealed to the bead **15** with a minimum amount of adhesive sealant **16**. An end cap **12** can then be placed over the seal **11**.

Another advantageous feature of the present invention is the wrinkled or “matte” surface of the liner ply **14** which can be seen in FIGS. **1** and **2**. The wrinkled surface is provided by the method and apparatus according to the present invention which causes equal lengths of the body ply **13** and liner ply **14** to adhere together before being wrapped around the mandrel **47**. As the plies are wrapped around the mandrel **47**, the much stiffer body ply **13** causes the liner ply **14** to become compressed. In other words, the body ply **13** initially defines a circumferential length corresponding to one revolution around the mandrel **47** and the liner ply **14** has an initial length per revolution equal to that of the body ply **13**. However, when wrapped, the liner ply **14** is forced into a circular section having a slightly smaller radius than the radius of the circle defined by the body ply **13**. As such, the liner ply **14** is circumferentially compressed relative to the body ply **13**.

The circumferential compression is advantageous if certain types of liner ply **14** are used because the compression may cause an initially smooth liner ply to have a wrinkled or matte surface once wrapped. The wrinkled surface finish has an “alligator skin” type appearance caused by many small peaks and valleys in the surface of the liner ply **14**. The wrinkled surface is highly advantageous because it dramatically decreases the amount of winding friction between the liner ply **14** and mandrel **47**. While not wishing to be bound by theory, it is believed that the decreased friction is due to the decreased surface area of the liner ply **14** (caused by the peaks and valleys thereof) which is in frictional contact with the mandrel **47**. The friction is decreased so much that the lubricant and lubricant roller **44** can preferably be eliminated. One preferred material for the liner ply **14** includes a polyester barrier layer **61** which becomes wrinkled with circumferential compression.

An alternative embodiment of the tubular container **10** according to the present invention is illustrated in FIG. **12** and includes two overlying body plies **13a, 13b**. This embodiment is advantageous if additional strength is necessary. A first body ply **13a** is adhered to the liner **14** in the fashion discussed above and passed through the pair of nip rollers **36**. A second body ply **13b** is coated with a wet adhesive and then brought into engagement with the underside of the first body ply **13a** so that they will be adhered together.

Many modifications and other embodiments of the invention will come to mind to one skilled in the art to which this invention pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. For example, the tubular containers according to the present invention are not necessarily helically wound but may instead be longitudinally wrapped to create a “convolute” tube having an axially extending seam. In addition, although the tubular containers according to the present invention

have been described primarily in connection with food products, it is to be understood that the containers could be used in connection with other products where the liner ply is advantageous such as, for example, ink or caulk. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

That which is claimed:

1. A liner ply for lining a tubular container having a wound fibrous paperboard body ply, said liner ply comprising:

a polymeric moisture barrier layer; and

an adhesive layer defining the outer surface of said liner ply, wherein said adhesive layer includes a heat-activatable polymeric adhesive which is adhered directly to the fibers of the body ply,

wherein said liner ply does not include aluminum foil or kraft paper support layers.

2. A liner ply for a tubular container as defined in claim 1 wherein said adhesive layer further comprises inner and outer coextruded sublayers each having a heat-activatable polymeric adhesive, said inner sublayer having an adhesive which is adhered to said barrier layer and said outer sublayer having a different adhesive which is adhered to the body ply.

3. A liner ply for lining a tubular container having a wound fibrous paperboard body ply, said liner ply comprising:

a polymeric moisture barrier layer; and

an adhesive layer defining the outer surface of said liner ply, wherein said adhesive layer includes a heat-activatable polymeric adhesive which is adhered directly to the fibers of the body ply, said adhesive layer further comprising an inner sublayer which includes ethylene acrylic acid for adhering to said barrier layer and an outer sublayer which includes ethylene methyl acrylate for adhering to the body ply.

4. A liner ply for a tubular container as defined in claim 1 wherein said liner ply further comprises a polymeric seal layer defining the inner surface of said liner ply, and wherein said seal layer has a melting temperature higher than the temperature at which said adhesive becomes activated.

5. A liner ply for a tubular container as defined in claim 4 wherein said seal layer includes a polyolefin polymer.

6. A liner ply for a tubular container as defined in claim 1 wherein said moisture barrier layer includes at least one of

the group of polyester, nylon, ethylene vinyl alcohol copolymer and blends thereof.

7. A liner ply for a tubular container as defined in claim 1 wherein said barrier layer further comprises a metallized coating.

8. A liner ply for a tubular container as defined in claim 1 wherein the liner ply has a thickness of less than about three mils.

9. A liner ply for lining a tubular container having a wound fibrous paperboard body ply, said liner ply comprising:

a polymeric moisture barrier layer; and

an adhesive layer defining the outer surface of said liner ply, wherein said adhesive layer includes a heat-activatable polymeric adhesive which is adhered directly to the fibers of the body ply,

wherein said liner ply does not include an aluminum foil support layer or an anaconda fold at an edge thereof.

10. A liner ply for a tubular container as defined in claim 9 wherein said adhesive layer further comprises inner and outer coextruded sublayers each having a heat-activatable polymeric adhesive, said inner sublayer having an adhesive which is adhered to said barrier layer and said outer sublayer having a different adhesive which is adhered to the body ply.

11. A liner ply for a tubular container as defined in claim 9 wherein said liner ply further comprises a polymeric seal layer defining the inner surface of said liner ply, and wherein said seal layer has a melting temperature higher than the temperature at which said adhesive becomes activated.

12. A liner ply for a tubular container as defined in claim 9 wherein said seal layer includes a polyolefin polymer.

13. A liner ply for a tubular container as defined in claim 9 wherein said moisture barrier layer includes at least one of the group of polyester, nylon, ethylene vinyl alcohol copolymer and blends thereof.

14. A liner ply for a tubular container as defined in claim 9 wherein said barrier layer further comprises a metallized coating.

15. A liner ply for a tubular container as defined in claim 9 wherein the liner ply has a thickness of less than about three mils.

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